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Description

Method and device for displaying navigational information for a vehicle

The invention relates to a method and a device in which navigational information for a vehicle is superimposed on an image of the vehicle environment, this graphic representation of a navigational representation being transformed by means of a perspective transformation.

Such a method or such a device is known from European patent application EP 0 406 946 A1.

In addition, there are navigation systems today which display to the driver the recommended route at a junction by means of pictograms and emit acoustic information, e.g. "Take the second turning on the right" or "Drive straight on at the roundabout". Some systems also additionally show the recommended route on a map.

A vehicle is deemed below to refer not just to land vehicles but also to watercraft and airplanes.

The object of the invention is to indicate a method and a device for displaying navigational information for a vehicle such that the route through road traffic to a defined destination is displayed to a vehicle driver in an intuitive and easily comprehensible manner.

According to the invention, this object is achieved with regard to the method by the features of Claim 1 and with regard to the arrangement by the features of Claim 10.

The further claims relate to preferred embodiments of the method according to the invention.

The invention will be described below with reference to embodiments represented in the drawings, in which:

Figures 1, 2, 3a, 3b and 4	show modes of displaying navigational information with the aid of a virtual pilot vehicle and
Figures 5a and 5b	show a representation for explaining the positioning of the virtual pilot vehicle.

According to the invention, navigational information for a vehicle is displayed intuitively and in an easily comprehensible manner in the form of a virtual pilot vehicle superimposed upon an image of the vehicle environment. The display mode and/or the position and/or the orientation and/or size of the virtual pilot vehicle are determined, for example, in accordance with the route information, speed, reference points for a recommended route and the position and orientation of the vehicle or of the camera for recording the vehicle environment.

In a preferred embodiment of the invention, the navigational information is represented with the aid of a virtual pilot in the form of a stylized vehicle which appears to be proceeding in front of the driver on the recommended route. Through its virtual driving maneuvers, the virtual pilot vehicle draws the attention of the driver to imminent real driving maneuvers.

Through its actions, the virtual pilot vehicle can display to the driver intuitively and in an easily comprehensible manner route recommendations or other action recommendations. Thus, for example:

1. a recommendation to "turn right" or "turn left", as shown in Figure 1, is represented by a virtual pilot vehicle having a correspondingly flashing indicator;

2. a recommendation to "turn left onto a certain road" or to "turn right onto a certain road" as shown in Figure 2, is represented by a correspondingly turning virtual pilot vehicle;

3. a recommendation to "drive carefully because of a safety hazard" approaching the driver, for example a traffic jam, roadworks, person driving on the wrong side of the road or similar, as shown in Figure 3a, is represented by a virtual pilot vehicle with its hazard warning flashers activated. In addition, further information can optionally be displayed, as shown in Figure 3b, via text or pictogram on a panel on the virtual pilot vehicle;

4. a recommendation to "reduce speed" as shown in Figure 4, is displayed by the brake lights on the virtual pilot vehicle flashing on if the driver is driving too fast, e.g. because of a prevailing speed limit or because there is a sharp bend approaching;

5. a recommendation to "keep the minimum distance from the vehicle ahead in accordance with the current speed" is displayed by a virtual pilot vehicle being positioned on the road such that it appears to be proceeding in front of the driver at precisely the minimum distance currently required. If a real vehicle is now located between the driver and the virtual vehicle, then the driver has driven up too close to the real vehicle in front.

Here, the virtual pilot vehicle is embedded in a video image of the real scene ahead of the vehicle of the driver and is shown on a display or projected in front of the driver onto the windshield of his/her vehicle.

Since the virtual pilot vehicle behaves in principle like a real vehicle guiding the driver, the recommendations and instructions which the virtual pilot displays visually are intuitively comprehensible to the driver.

The pilot vehicle appears to be proceeding at a certain distance, the pilot distance d, ahead of the actual vehicle. This distance is advantageously dependent on the current speed of the vehicle and possibly on the maximum speed permissible or recommended at the current point.

This pilot distance is determined for example as follows:
Let the driving speed v and any applicable maximum speed v_0 be given. The unknown is the virtual pilot distance d.
If no maximum speed applies or if $v<v_0$, then

$$d(v) = \max\left(5m, \frac{v*36}{20}s\right).$$

If $v>v_0$, it is recommended that the driver reduce speed. This is signaled by a shortening of the distance, i.e.

$$d(v) = \max\left(5\mathrm{m}, \frac{v_0*36}{20}\mathrm{s} - \frac{c*(v-v_0)*36}{20}\mathrm{s}\right).$$

Here, the variable c can be chosen as fixed, e.g. c=2, or interpreted as a function of the type of road, e.g. c=2 in urban traffic, c=5 on country roads, c=6 on motorways.

Furthermore, in a preferred embodiment of the invention, the pilot position in global coordinates is determined as follows:

Let the vehicle position $\vec{P}$ in global coordinates, e.g. measured via GPS, the information about the route recommended by the navigational system in the form of n reference points $\vec{R}_i$ and the distance by which the pilot proceeds ahead of the vehicle on the recommended route d be given.

The unknown is the pilot position $\vec{L}$ in global coordinates and the pilot orientation $\vec{O}$ in global coordinates, where $\vec{O}$ forms the unit vector in the line of sight of the virtual pilot vehicle.

In order to determine the pilot position on the route, the position of the vehicle on the route must first be determined. To this end, the measured position $\vec{P}$ of the vehicle is projected onto the route, as shown in Figure 5a and 5b.

One way of doing this is to find the point $\vec{P}_0 = (1-t_0)\vec{R}_{i_0} + t_0\vec{R}_{i_0+1}$ on the route which has the minimum distance in the sense of the least squares to $\vec{P}$, i.e.

$f(t,i)=\left|\vec{P}-((1-t)\vec{R}_i+t\vec{R}_{i+1})\right|^2$ with $t\in[0,1[$ and $i\in\{1,\ldots,n\}$ has an absolute minimum at the point $t=t_0$ and $i=i_0$. The pilot position $\vec{L}$ is then given by $\vec{L}=(1-t_1)\vec{R}_{i_1}+t_1\vec{R}_{i_1+1}$, where t_1 and i_1 are determined by

$$d(v)=\left|\vec{L}-\vec{R}_{i_1}\right|+\left|\vec{P}_0-\vec{R}_{i_0+1}\right|+\sum_{i=i_0+1}^{i_1-1}\left|\vec{R}_{i+1}-\vec{R}_i\right|.$$

The pilot orientation is now given by

$$\vec{O}=\frac{1}{N}\left(\frac{(1-t_1)}{\left|\vec{R}_{i_1+1}-\vec{R}_{i_1-1}\right|}(\vec{R}_{i_1+1}-\vec{R}_{i_1-1})+\frac{t_1}{\left|\vec{R}_{i_1+2}-\vec{R}_{i_1}\right|}(\vec{R}_{i_1+2}-\vec{R}_{i_1})\right) \text{ with}$$

$$N=\left|\frac{(1-t_1)}{\left|\vec{R}_{i_1+1}-\vec{R}_{i_1-1}\right|}(\vec{R}_{i_1+1}-\vec{R}_{i_1-1})+\frac{t_1}{\left|\vec{R}_{i_1+2}-\vec{R}_{i_1}\right|}(\vec{R}_{i_1+2}-\vec{R}_{i_1})\right|$$

Through a perspective transformation, a 2-dimensional representation of the pilot is determined from the pilot position and the pilot orientation for superimposing on the video image or for projecting onto the windshield:

Case 1: Superimposing on a video image

Let the pilot position $\vec{L}$, the pilot orientation $\vec{O}$, the parameters of the real camera and a 3-dimensional description of the pilot model be given.
The unknown is the 2-dimensional representation of the pilot.
The position of the pilot model can be calculated in global co-ordinates from $\vec{L}$ and $\vec{O}$. The projection images are computed from the parameters of a camera for recording the vehicle environment, and the model description of the pilot vehicle is projected onto the display plane.

The system is in this case equipped with a camera which records what happens in front of the vehicle. The virtual pilot vehicle is embedded into the individual video images in accordance with the route computed for the journey. The augmented reality image thus

obtained is shown on a display within visual range of the driver (Annex, photo 6a).

In addition, for example, the recommended route for the journey is displayed. The further path of the virtual vehicle is also visually displayed by means of the route for the journey (Annex, Photo 6b)

Case 2: projection onto the windshield

Let the pilot position $\vec{L}$, the pilot orientation $\vec{O}$, the position and line of sight of the driver determined via sensors and a 3-dimensional description of the pilot model be given.
The unknown is the 2-dimensional representation of the pilot.
The position of the pilot model in global coordinates can be calculated from $\vec{L}$ and $\vec{O}$. The projection images are computed from the parameters of the eye position and line of sight, and the model description of the pilot vehicle is projected onto the display plane.

In this case, the eye position of the driver is determined, for example, first via a tracking system. Via a projection apparatus, the virtual vehicle is projected onto the appropriate point on the windshield in accordance with the route computed for the journey. (Annex, Photo 6c)

The recommended route for the journey, for example, is additionally projected onto the windshield. (Annex, Photo 6d)